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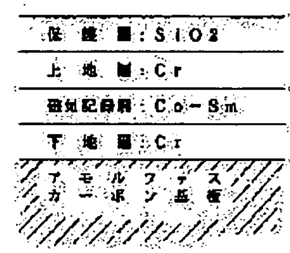
(54) **PRODUCTION OF MAGNETIC RECORDING MEDIUM**

(57)Abstract:
PURPOSE: To obtain a magnetic recording medium having high coercive force and adaptable to high recording density with a low-cost Co-Sm alloy material as the material of a magnetic recording layer.
CONSTITUTION: A film of Cr as an underlayer, a film of a Co100-x-y-Smx-Ry alloy [R is a rare earth element other than Sm, (x) is 1-30at.% and (y) is 0-10at.%] as a magnetic recording layer and a film of Cr as an upper layer are formed on an amorphous carbon substrate at ≤400°C temp. of the substrate and then heating is carried out. at 250-650°C in inert gas or in vacuum.



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DETAILED DESCRIPTION

[Detailed description]
[0001]
[Field of the Invention] the manufacture technique of magnetic-recording mediums, such as a magnetic disk, that this invention is used for external recording devices, such as a computer, -- being related -- especially -- high recording density correspondence -- high -- it is related with the manufacture technique of a coercive force magnetic-recording medium
[0002]
[A Prior art and Object of the Invention] In recent years, large-capacity-izing / high recording density-ization of the magnetic disk used for the external recording device of a computer are increasingly promoted by increase of amount of information. Generally, the relation of the following formula between track recording density, and coercive force Hc of a magnetic-recording medium, residual magnetic flux density Br and magnetic layer thickness t is.
[0003] Track-recording-density **Hc/(Br*t)
Therefore, in order to raise recording density, it is necessary to raise coercive force. If 1800 or more Oes are demanded and a future technical trend is taken into consideration as coercive force also in the present condition, 3500 and the further high coercive force-ization called 4500Oe are assumed. The Co-Cr-Pt alloy system material and Co-Sm alloy system material which have a mainly big crystal magnetic anisotropy are examined to the raise in the coercive force of such a magnetic-recording medium.
[0004] As a Co-Cr-Pt alloy system material, although Co-Cr-Pt and Co-Cr-Pt-Ta, Co-Cr-Pt-B, Co-nickel-Cr-Pt, etc. are used, in order to use Pt which is very expensive noble metals, steep elevation of a cost is not escaped. What example of that research is made as a medium using the Co-Sm alloy system material. For example, a Co-Sm alloy is used and H.C.Theuerer etc. is substrate temperature. The magnetization crystal layer within a field of high coercive force is produced on 500-degree C conditions (J. Appl.Phys. 40 and 2944 (1969)). Recently, moreover, E.M.T.Velu and D.N.Lambeth etc. a part for the argument about the Co(82at%)-Sm (18at%) alloy medium formed on glass and the aluminum substrate -- announcing -- **** (J. -- Appl.Phys. -- 69 and 5175 (1992) --) and IEEE Trans.Magn. -- the medium of a maximum of 3000 Oes is obtained as 28, 3249 (1992), and coercive force However, the further high coercive force medium is wished that it mentioned above.
[0005] moreover, it sets as the formation technique of a ferromagnetic thin film in the Japanese Patent Publication No. 71165 five to] official report in [after forming a Co(85 - 65at%)-Sm (15 - 35at%) alloy] a vacuum or a non-oxidizing atmosphere -- the technique of annealing at 650 to 800 degree C is indicated It is in the vacuum of 1mTorr as indicated by the Japanese Patent Publication No. 71165 [five to] official report in this invention persons conducting the experiment about a Co-Sm alloy medium. Heat treatment for 700 degrees C / 1 minute was performed. The result is as follows.
[0006] in an experiment of this invention persons, a direct Co-Sm alloy layer is first formed on an amorphous carbon substrate according to the Japanese Patent Publication No. 71165 [five to] official report (in this official report, reference is not made at all about the quality of the material of a substrate) -- although heat-treated at 700 degree C, this [coercive force's] was low and was not satisfactory at all then -- next, an amorphous carbon substrate top -- substratum layer Cr, magnetic-recording layer Co(83at%)-Sm (17at%), upper stratum Cr, and protection layer SiO2 it forms one by one -- it heat-treated at 700 degree C However, now, coercive force was not what can be satisfied.
[0007] This invention persons thought whether coercive force would be satisfied, as a result of heat-treatment temperature is too high and promoting a diffusion of Cr too much, although lessons was taken from this cause and many things were guessed. Then, when aforementioned each class was formed on the amorphous carbon substrate and heat-treatment temperature was made into 250 to 650 degree C, the magnetic-recording medium with the coercive force which can be satisfied was able to be obtained.
[0008] That is, not being obtained made clear what can be satisfied even if it applies the technique of the Japanese Patent Publication No. 71165 [five to] official report to the magnetic-recording medium of an amorphous carbon substrate as it is. this invention aims at offering the manufacture technique for realizing the magnetic-recording medium which has the high coercive force of high recording density correspondence in view of the above-mentioned point using the cheap Co-Sm alloy system material which does not contain Pt as a magnetic-recording layer using an amorphous carbon substrate.
[0009]
[The means for solving a technical problem] In this invention, the amorphous carbon substrate which has the thermal resistance of 1000 degrees C or more was used as a substrate. Abbreviation which is the magnetization temperature of nickel-P in aluminum alloy substrate which gave nickel-P plating currently used for general present 290 degrees C is the maximum service temperature. Moreover, possibility that the softening point will be in the problem and near about 500 degree C in a

tempered-glass substrate, and deformation of a substrate will arise is high. [which the ion in a strengthening processing layer diffuses in a layer by the heating at high temperature] Therefore, these are not suitable as a substrate in this invention.
[0010] In this invention, it is premised on a Co-Sm-R (R is rare earth elements other than Sm) alloy (however, R component 0at% is included), and the magnetic-recording medium which possesses Cr, Cr alloy, or the nitride of Cr as an upper stratum as Cr or Cr alloy, and a magnetic-recording layer as a substratum layer on an amorphous carbon substrate. In this invention, the Co-Sm-R alloy as a magnetic-recording layer is used as a Co(100-x-y)-Sm(x)-R (y) alloy (x= 1 - 30at%, and y= 0 - 10at %), and it is substrate temperature. Below 400 degrees C It is about a substratum layer, a magnetic-recording layer, and an upper stratum after **** and in an inert atmosphere (inside of inert gas or a vacuum). A magnetic-recording medium is obtained by heat-treating 250 to 650 degree C.
[0011] In addition, as the Co-Sm-R alloy as a magnetic-recording layer contains y= 0, it contains the Co-Sm alloy without R component. Moreover, Pr, Ce, Gd, etc. can be mentioned as rare earth elements as an R component. It is in the role of a substratum layer controlling the crystal stacking tendency of a magnetic-recording layer (magnetic layer), and raising coercive force further.
[0012] The role of an upper stratum is to diffuse Cr into a magnetic layer and attain high coercive force while it prevents oxidization of Sm which is the component of a magnetic-recording layer (magnetic layer). As an upper stratum, it may replace with Cr, Cr alloy, or the nitride of Cr, and the nitride of the alloy containing a non-diffusibility metallic element and this ******** metallic element or this ******** metallic element may be used.
[0013] A non-diffusibility here means that it is hard to be spread rather than Cr or C, and Si, Ti, V, Zr, Nb, Mo, Ta, and W can be illustrated as a non-diffusibility metallic element. However, when using the nitride of the alloy which contains a non-diffusibility metallic element and this ******** metallic element as an upper stratum, or this ******** metallic element, the effect of an upper stratum is only the antioxidizing effect of Sm.
[0014] Moreover, you may form by carrying out the laminating of two or more magnetic layers which consist a magnetic-recording layer of a Co-Sm-R alloy, and the non-magnetic layer which consists of Cr which separates between these magnetic layers, or a Cr alloy. Thus, by dividing a magnetic layer by the non-magnetic layer, by Cr in a non-magnetic layer advancing between the crystal grain of Co of a magnetic layer, the magnetic interaction between magnetic crystal grain is reduced, and the further high coercive force-ization can be attained.
[0015] Although a protection layer is ****ed like the conventional common magnetic-recording medium in the outside of an upper stratum, they are carbon, hydrogenation carbon, SiC and SiO2, and ZrO2 in a protection layer. A grade is used. Moreover, before the protection stratification is available for heat-treatment, and after formation is convenient for it. However, when heat-treating after the protection stratification, it is desirable to form a protection layer with the material which is hard to diffuse in the layer under a protection layer. For example, SiO2 It cannot be said that the material which contains C preferably and generally is desirable.
[0016]
[Example] The example of this invention is explained below.
In a [example 1] substrate, it is a density. 1.5g/cm3 and Vickers hardness The amorphous carbon substrate of 1.89" (outer diameter of 48mm) which has the property which becomes 650 was used. And the in-line formula transit type sputtering system performed **** for this substrate on the following procedure and conditions after precision washing (alkali-cleaning -> rinse -> rinse -> hot-pure-water xeransis). In addition, the membrane structure of an example 1 is shown in drawing 1 .
[0017] 1) Substratum layer:CrAr gas ** 3mTorr, the substrate temperature of 30 degrees C, substrate bias voltage-200V, thickness 100nm2 magnetic-recording layer:Co(83at%)-Sm (17at%)
Ar gas ** 3mTorr, the substrate temperature of 30 degrees C, substrate bias voltage-200V, 25nm 3 up stratum [of thicknesss]:CrAr gas ** 3mTorr, the substrate temperature of 30 degrees C, 5in heat-treatment vacuum x10-7Torr in the inside of 5nm 4 inert atmosphere of substrate bias voltage-200 V and thicknesss, substrate temperature 300 degrees C and a heating time -- 1 minute protection [5] layer:SiO2 total gas ** 3mTorr (Ar:O 2 = 95:5) and substrate temperature Evaluation of 200 degrees C and the magnetic-recording medium obtained 15nm of thicknesss asked for coercive force by the following technique.
[0018] It asked for coercive force from the M-H loop acquired by impressing to maximum magnetic-field 15kOe by VSM (oscillating sample type magnetometer). A result is shown in Table 1.
The [example 2] substrate is the same as that of an example 1, and performed **** on the following procedure and conditions by the in-line formula transit type sputtering system after precision washing.
[0019] 1) Substratum layer:CrAr gas ** 3mTorr, the substrate temperature of 28 degrees C, substrate bias voltage-200V, thickness 100nm2 magnetic-recording layer:Co(83at%)-Sm (17at%)
Ar gas ** 3mTorr, the substrate temperature of 28 degrees C, substrate bias voltage-200V, 35nm 3 up stratum [of thicknesss]:CrAr gas ** 3mTorr, the substrate temperature of 28 degrees C, 5in heat-treatment vacuum x10-7Torr in the inside of 5nm 4 inert atmosphere of substrate bias voltage-200 V.and thicknesss, substrate temperature 600 degrees C and a heating time -- 1 minute protection [5] layer:SiO2 total gas ** 3mTorr (Ar:O 2 = 95:5) and substrate temperature Evaluation of 200 degrees C and the magnetic-recording medium obtained 15nm of thicknesss asked for coercive force like the example 1. A result is shown in Table 1.
The [example 3] substrate is the same as that of an example 1, and performed **** on the following procedure and conditions by the in-line formula transit type sputtering system after precision washing. In addition, the membrane structure of an example 3 is shown in drawing 2 .
[0020] 1) Substratum layer:CrAr gas ** 3mTorr, the substrate temperature of 30 degrees C, substrate bias voltage-200V,

thickness 100nm2 magnetic-recording layer (nine layers of a magnetic layer / non-magnetic layer / magnetic layer / non-magnetic layer / magnetic layer / non-magnetic layer / magnetic layer / non-magnetic layer / magnetic layer)
- Magnetic layer:Co(83at%)-Sm (17at%) x five layer Ar gas ** 3mTorr, The substrate temperature of 30 degrees C, substrate bias voltage-200V, thickness 7nm and non-magnetic layer:Cr x four layer Ar gas ** 3mTorr, The substrate temperature of 30 degrees C, substrate bias voltage-200V, 2nm 3 up stratum [of thicknesss]:CrAr gas ** 3mTorr, 5in heat-treatment vacuum x10-7Torr in the inside of the substrate temperature of 30 degrees C, and 5nm 4 inert atmosphere of substrate bias voltage-200 V and thicknesss, substrate temperature 600 degrees C and a heating time -- 1 minute protection [5] layer:SiO2 total gas ** 3mTorr (Ar:O 2 = 95:5) and substrate temperature Evaluation of 200 degrees C and the magnetic-recording medium obtained 15nm of thicknesss asked for coercive force like the example 1. A result is shown in Table 1.
Except composition of a [example 4] magnetic-recording layer, it is the same as that of an example 1, and composition of a magnetic-recording layer is as follows.
[0021] Magnetic-recording Layer: Co(78at%)-Sm(15at%)-Pr (7at%)
Except composition of a [example 5] magnetic-recording layer, it is the same as that of an example 1, and composition of a magnetic-recording layer is as follows.
Magnetic-recording Layer: Co(80at%)-Sm(18at%)-Ce (2at%)
Except composition of a [example 6] magnetic-recording layer, it is the same as that of an example 1, and composition of a magnetic-recording layer is as follows.
[0022] Magnetic-recording Layer: Co(81at%)-Sm(17at%)-Gd (2at%)
The [example 1 of comparison] substrate is the same as that of an example 1, and performed **** on the following procedure and conditions by the in-line formula transit type sputtering system after precision washing.
1) Substratum layer:CrAr gas ** 3mTorr, the substrate temperature of 30 degrees C, substrate bias voltage-200V, thickness 100nm2 magnetic-recording layer:Co(65at%)-Sm (35at%)
Ar gas ** 3mTorr, the substrate temperature of 30 degrees C, substrate bias voltage-200V, 35nm 3 up stratum [of thicknesss]:CrAr gas ** 3mTorr, the substrate temperature of 30 degrees C, 5in heat-treatment vacuum x10-7Torr in the inside of 5nm 4 inert atmosphere of substrate bias voltage-200 V and thicknesss, substrate temperature 700 degrees C and a heating time -- 1 minute protection [5] layer:SiO2 total gas ** 3mTorr (Ar:O 2 = 95:5) and substrate temperature Evaluation of 200 degrees C and the magnetic-recording medium obtained 15nm of thicknesss asked for coercive force like the example 1. A result is shown in Table 1.
The [example 2 of comparison] substrate is the same as that of an example 1, and performed **** on the following procedure and conditions by the in-line formula transit type sputtering system after precision washing.
[0023] 1) Substratum layer:CrAr gas ** 3mTorr, the substrate temperature of 28 degrees C, substrate bias voltage-200V, thickness 100nm2 magnetic-recording layer:Co(65at%)-Sm (35at%)
Ar gas ** 3mTorr, the substrate temperature of 28 degrees C, substrate bias voltage-200V, 35nm 3 up stratum [of thicknesss]:CrAr gas ** 3mTorr, the substrate temperature of 28 degrees C, 5in heat-treatment vacuum x10-7Torr in the inside of 5nm 4 inert atmosphere of substrate bias voltage-200 V and thicknesss, substrate temperature 600 degrees C and a heating time -- 1 minute protection [5] layer:SiO2 total gas ** 3mTorr (Ar:O 2 = 95:5) and substrate temperature Evaluation of 200 degrees C and the magnetic-recording medium obtained 15nm of thicknesss asked for coercive force like the example 1. A result is shown in Table 1.
[0024]
[Table 1]

	保磁力 (Oe)
実施例1	3630
実施例2	2810
実施例3	4370
実施例4	2680
実施例5	2900
実施例6	2810
比較例1	1080
比較例2	1460

Coercive force sufficient in the examples 1-6 is obtained from the above-mentioned result, a magnetic-recording layer is used as a Co(100-x-y)-Sm(x)-R (y) alloy (x= 1 - 30at%, and y= 0 - 10at %), and it is substrate temperature. Below 400 degrees C It is after **** and in an inert atmosphere about a substratum layer, a magnetic-recording layer, and an upper stratum. It was checked by heat-treating 250 to 650 degree C that high coercive force is obtained.
[0025] Moreover, it was also checked by carrying out the laminating of two or more magnetic layers which consist a magnetic-recording layer of a Co-Sm alloy, and the non-magnetic layer which consists of Cr which separates between these magnetic layers, or a Cr alloy, and forming it like an example 3, that the further high coercive force-ization can be attained. on the other hand in the example 1 of a comparison, it is 65-35% with composition of Co-Sm out of range, and heat-treatment temperature is out of range By being 700 degrees C, high coercive force did not have profit.

[0026] Moreover, at the example 2 of a comparison, heat-treatment temperature is within the limits. Although it was 600 degrees C, high coercive force was not obtained by [with composition of Co-Sm out of range] being 65-35%.
[0027]
[Effect of the invention] As explained above, according to this invention, the effect that the magnetic-recording medium which has the high coercive force of high recording density correspondence as a magnetic-recording layer using the cheap Co-Sm-R alloy which does not contain Pt is realizable is acquired. Moreover, the effect that the further high coercive force-ization can be attained is acquired by carrying out the laminating of two or more magnetic layers which consist a magnetic-recording layer of a Co-Sm-R alloy, and the non-magnetic layer which consists of Cr which separates between these magnetic layers, or a Cr alloy, and forming it.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim]
[Claim 1] On an amorphous carbon substrate, as a substratum layer, Cr or Cr alloy, In the magnetic-recording medium which possesses Cr, Cr alloy, or the nitride of Cr as a magnetic-recording layer as a Co-Sm-R (R is rare earth elements other than Sm) alloy (however, R component 0at% is included), and an upper stratum The Co-Sm-R alloy as a magnetic-recording layer is used as a Co(100-x-y)-Sm(x)-R (y) alloy (x= 1 - 30at%, and y= 0 - 10at %), and it is substrate temperature. Below 400 degrees C It is after **** and in an inert atmosphere about a substratum layer, a magnetic-recording layer, and an upper stratum. The manufacture technique of the magnetic-recording medium characterized by heat-treating 250 to 650 degree C.
[Claim 2] The manufacture technique of the magnetic-recording medium the claim 1 publication characterized by using the nitride of the alloy which replaces with Cr, Cr alloy, or the nitride of Cr, and contains a non-diffusibility metallic element and this ******** metallic element as the aforementioned up stratum, or this ******** metallic element.
[Claim 3] The aforementioned non-diffusibility metallic element is the manufacture technique of Si, Ti, V, Zr, Nb, Mo, Ta, or the magnetic-recording medium the claim 2 publication characterized by being W.
[Claim 4] The manufacture technique of the magnetic-recording medium any one publication of the claim 1 characterized by forming by carrying out the laminating of two or more magnetic layers which consist the aforementioned magnetic-recording layer of a Co-Sm-R alloy, and the non-magnetic layer which consists of Cr which separates between these magnetic layers, or a Cr alloy, - the claim 3.

[Translation done.]